Research

FOR FARMERS

WINTER — 1963

CANADA DEPARTMENT OF AGRICULTURE

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CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

HON. ALVIN HAMILTON, *Minister* — S. C. BARRY, *Deputy Minister*

NOTES AND COMMENTS

Scientists at the Animal Diseases Research Institute have been trying to find a technique that will permit rapid detection of leptospirosis organisms in tissue or fluid and hence facilitate an earlier diagnosis. On page 3, Dr. A. Robertson reports that the fluorescent antibody technique will do the trick. As he states: "It establishes the presence of the causative organism in the urine and tissue of acutely infected animals and 'carriers'." While the efficiency of the technique appears to be somewhat lower than that of more elaborate cultural methods, Dr. Robertson believes the fluorescent method will undoubtedly serve as a useful adjunct in the examination of specimens unsuitable for isolation studies.

* * *

In their article on "Pasture Bloat" (page 11), Drs. McArthur and Miltimore report that it may be possible to obtain legumes with a sufficiently high lipid content and thereby not cause bloat. The plant, they say, contains both foaming and anti-foaming components and the interaction between them determines whether or not the animal will bloat. They explain that the production of non-bloating legumes requires a study of the effect of factors such as maturity, temperature, day length and soil fertility on the balance of the components in the growing plant. "So far," they state, "it has not been possible to screen bloating legumes for safe varieties or genotypes because the laboratory procedures are still under development. The solution may be low bloat potential legumes grown and harvested under optimum conditions".

* * *

Some irrigation projects that have been constructed on old lakebeds with poor natural drainage such as the Rush Lake project near Swift Current, Sask., are gradually becoming saline—so reports J. C. van Schaik in his article, "Spring Flood Irrigation on the Prairies" (page 16). To prevent this salt accumulation, it is suggested that spring flood irrigation be applied rather than summer irrigation. In the spring the upward movement of water with its dissolved salts is slower than in summer because of lower evaporation and transpiration. Accumulation of salts at or near the soil surface, which is detrimental to crop growth, is therefore slower in the spring than during the hot summer months. "To minimize surface salt accumulation and thereby maintain the productivity of the soil," writes Mr. van Schaik, "spring flood irrigation is recommended. Any apparent benefits from summer irrigation in these areas are offset in the long run by the harmful effects of salinization."

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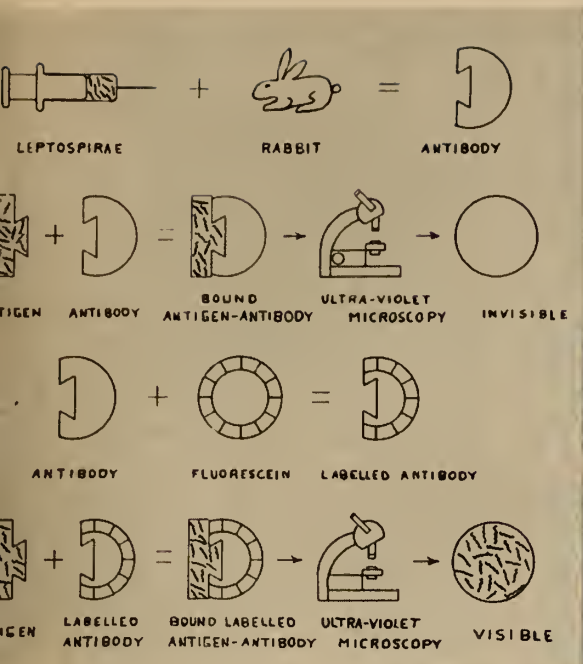
Cover Photo: **Spring flood scheme on South Rush Lake near Swift Current, Sask. (See story p. 16.)**



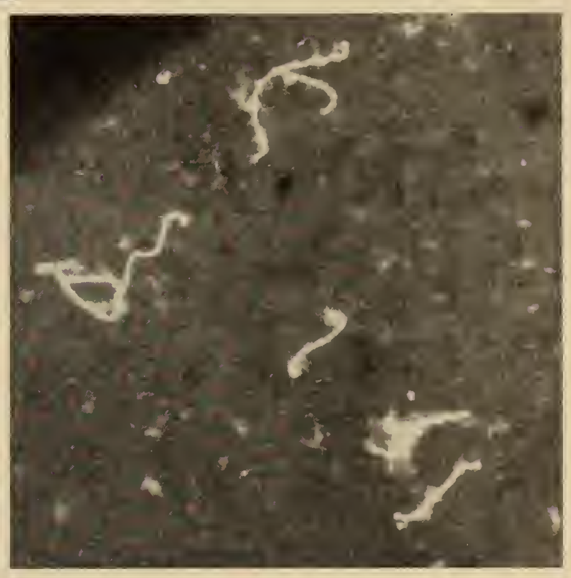
Left: **Diagrammatic representation of the fluorescent technique for demonstrating leptospirae. Author (right) using fluorescent microscopy for the diagnosis of leptospirosis.**

Below: **Leptospirae grown in culture medium as demonstrated by the fluorescein labelled antibody technique. 800X.**

Fluorescent Antibody Technique . . .

A Newer Method for Diagnosing Leptospirosis

A. Robertson



LEPTOSPIROSIS is an important disease of cattle[1] and swine and a necessary preliminary step in its control and eradication is rapid and accurate diagnosis. The condition has been studied at the Animal Diseases Research Institute since 1956 and *Leptospira pomona,* one of the causative agents, has been found to be the prevalent serotype in Canada.

> A necessary preliminary step in the control and eradication of leptospirosis is rapid and accurate diagnosis. The fluorescent antibody technique provides such a method. It establishes the presence of the causative organism in the urine and tissue of acutely infected animals and "carriers".

The most prominent clinical manifestations of the infection in adult cattle are abortion, secretion of abnormal thick yellowish milk and occasionally the occurrence of blood pigment in the urine. Infection in young calves often terminates in death. Abortion is the chief symptom in sows.

The clinical diagnosis of leptospirosis is difficult and it is usually necessary to resort to laboratory studies for confirmation. A confirmatory test requires the actual isolation of the organism. We find this is time-consuming as it involves the production of the disease in experimental animals, the inoculations having to be made on the farm with samples of urine or kidney tissue. Leptospirae do not stain with the usual aniline dyes and their presence cannot be demonstrated by simple staining methods as is done with many other bacterial infections. We have been trying to find a technique which would permit rapid detection of the organisms in tissue or

Dr. Robertson is with the Serology Unit, Animal Diseases Research Institute, Health of Animals Division, Hull, Que.

[1]*Research for Farmers,* Spring, 1958.

fluid and facilitate an earlier presumptive diagnosis.

With this in mind, a fluorescent antibody technique has been investigated at the Animal Diseases Research Institute. The antibody is obtained from the blood serum of rabbits hyperimmunized with leptospiral cultures. A fluorescent dye is attached by chemical means to the antibodies and this produces a specific staining reagent. The specimen to be studied—a drop of urine or touch-preparation of kidney tissue on a microscope slide—is flooded with the stain. The labelled antibodies become attached specifically to any leptospirae present by means of the antibody-antigen union. The fluorescent antibodies bound to these organisms render them visible when the preparation is viewed by means of a microscope equipped with an ultraviolet light source and appropriate filters.

Left: Leptospiral organisms in calf urine as revealed by the immunofluorescent method. 800X. **Right:** L. pomona in calf kidney tissue demonstrated by the labelled antibody technique. 800X.

We experimentally infected with *L. pomona* urine and kidney material from animals of various species and examined kidney specimens obtained from an abattoir by this fluorescent antibody technique. Our preliminary studies indicate that the method will effectively demonstrate the presence of leptospirae provided they are sufficiently numerous. The efficiency of the technique appears to be somewhat lower than that of more elaborate cultural methods. However, the fluorescent method will undoubtedly serve as a useful adjunct in the examination of specimens unsuitable for isolation studies.

European red mite adult.

These Organisms Exhibit Surprising Adaptability for Survival and Spread

How Cold-Hardy Are Mites?

A. W. MacPhee

DURING the past few years at the Canada Department of Agriculture Research Station, Kentville, N.S., we have measured the cold-hardiness of many species of orchard insects and mites to determine the effect of the extremes of low winter temperature on the overwintering stages. The most intensively studied species of mite was the European red mite, which was probably introduced to Nova Scotia from Europe about 50 years ago.

We used the freezing point method to measure cold-hardiness, a method based on the fact that the winter egg of this mite species survives low temperature by super-cooling and is killed when freezing occurs. The freezing point is the temperature of the individual eggs just before freezing occurs when the temperature is lowered; and is indicated by a sharp temporary temperature rise. We determined the freezing point of individual eggs and calculated the mean and range of population samples.

In our investigations at Kentville, we found that a temperature of −24°F. killed about 50% of the European red mite winter eggs in Nova Scotia, and all in the sample were killed by −29°F. Low winter temperatures in most fruit growing areas of Nova Scotia reach only about −20°F., while in New Brunswick and Quebec the winter's lowest temperature is often −30°F. or lower, although

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the European red mite is a pest in all three of these areas.

In the face of these paradoxical facts, the next step we took was to measure the cold-hardiness of overwintering mite eggs from New Brunswick. A low of $-35°F$. killed only 50% of the eggs and $-40°F$. was required to kill 100%. Clearly, there was a very great and obviously important difference in the cold-hardiness of winter mite eggs from the two areas. Were these mites from New Brunswick a different species from the Nova Scotia mites, unrecognized morphologically, or were they an adapted form of the same species, or was the difference due to environmental conditioning factors of the eggs or the parent mites?

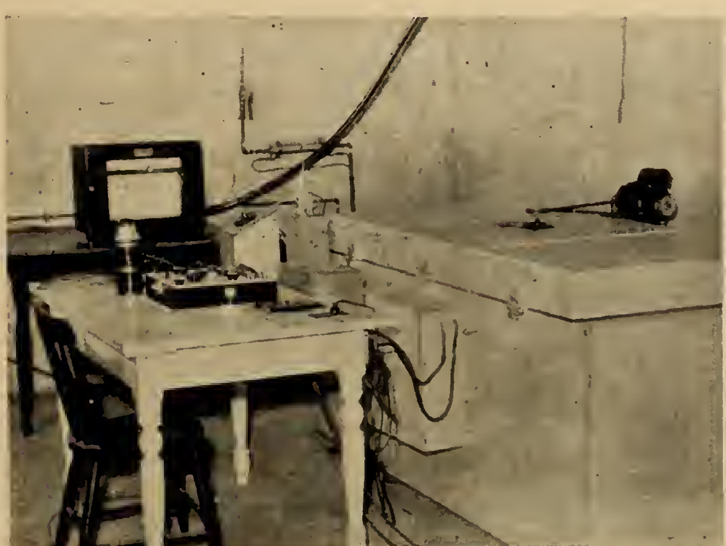
We checked on environmental factors by collecting eggs from the orchards at intervals from the fall to midwinter, holding them at 34°F., and testing their cold-hardiness soon after collection and subsequently at intervals of about one month. No change in cold-hardiness attributable to the different environmental conditions was detected.

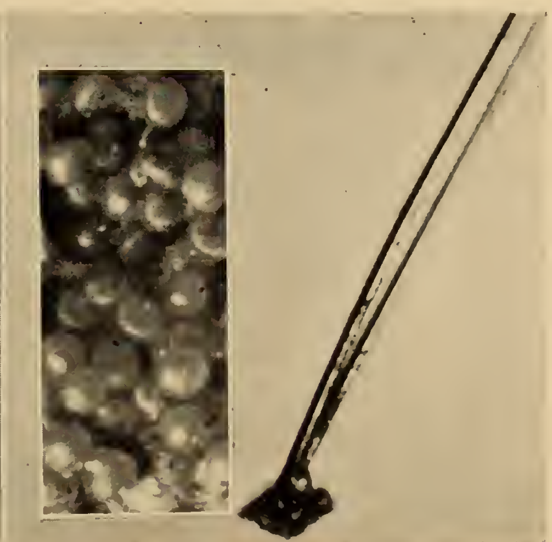
There was then almost certainly a real difference of an inheritable nature. Females of the Nova Scotia mite were first mated with males of the New Brunswick mite and the reciprocal cross was made. The cold-hardiness of the winter egg progeny of the first cross produced susceptible eggs similar to Nova Scotia mite eggs and the reciprocal cross eggs partly susceptible and partly cold-hardy similar to the New Brunswick mite. These results indicate that the cold-hardiness was due to a single recessive factor that was sex-linked.

Was it possible that this difference in response to low temperatures had arisen by adaptation? We undertook a breeding experiment to see if cold-hardiness could be increased artificially. We exposed a sample of eggs from a Nova Scotia orchard to low temperature ($-25°F$.) that killed about 90% of the eggs allowing the more cold-hardy 10% to survive. These were propagated during the summer, and the next winter the selection pressure of low temperature was again applied. This procedure was continued on the successive progeny for four years and resulted in the development of a cold-hardy form. We examined a large number of European red mite eggs from a Nova Scotia orchard and found that only a fraction of one per cent were resistant to below $-30°F$., whereas 91% of the progeny of the fourth selected population survived $-30°F$., and were almost identical in cold-hardiness to the New Brunswick form of the mite. The increase in cold-hardiness was caused by an increase in the percentage of eggs falling in the resistant category (i.e. around $-35°F$.) and not because there was a gradual shift in the whole population. Therefore there is no reason to doubt that the cold-hardy European red mite in New Brunswick (and Quebec) is the result of a simple adaptation of the more susceptible form of the species.

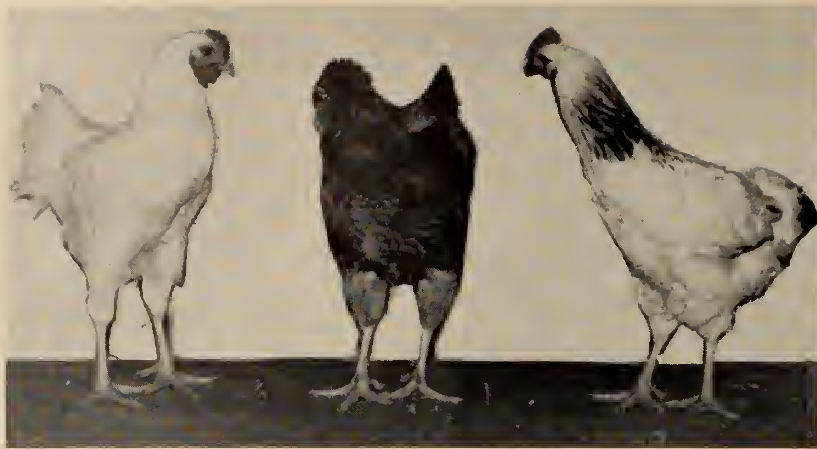
The factor for cold-hardiness probably exists in most susceptible populations in extremely small proportions. It probably increased in the Nova Scotia population since its introduction from Europe to a point (0.5% cold-resistant) where increase in cold-hardiness could occur rapidly by strong selection as indicated in the selection tests.

This type of adaptation, we have found, is very similar to that observed in development of resistance to pesticides in many insects and mites. Another well substantiated case of adaptability is the development of color change (industrial melanism) in certain moths in Europe in response to darkening by industrial smoke and soot of the bark of trees on which the moths rest. The selection pressure was predation by birds of the light colored form which were more easily found. The dark form previously present, but extremely rare, increased and became a major proportion of the population as the light form was removed.





Left: **Deep-freeze box produces temperatures down to $-50°F$. Other equipment includes a manual potentiometer and a temperature recording potentiometer.** ***Right:*** **A sensitive thermocouple (note mite egg touching the point) is used to determine freezing points of individual eggs.** ***Inset:*** **European red mite winter eggs.**



Representatives of strains used in broiler breeding research showing differences in type and plumage. L/r: Dominant White, New Hampshire, Columbian Rock.

Is Plumage Color Important in Broiler Breeding?

Leonard Griesbach

PLUMAGE color is an important consideration in the development of broiler breeds. Broilers with white plumage have consumer preference over colored birds because they usually present a cleaner, more attractive appearance when dressed. Colored strains, however, may have some desirable characteristics which could be utilized in the development of broiler strains. Work at the CDA Research Station, Fredericton, N.B., includes studies of the relationship of plumage color to broiler characteristics.

It has been shown at Fredericton and at other research institutions that certain genes affecting plumage color are associated to some small extent with rate of body growth. Our studies indicate that some further improvement in rate of gain might be made by taking this knowledge into consideration. For instance, in a progeny test of crossbred males derived from New Hampshires and Columbian Rocks, we obtained a body weight advantage of 1.6 per cent for broilers with red plumage over their brothers and sisters with white plumage, at 9 weeks of age. This difference may appear to be of little importance but when applied to the large numbers of broilers marketed by individual growers today it becomes of economic significance.

Another use of plumage color is in producing autosexing crosses of broilers. It is well known that in crossing New Hampshire males with Columbian Rock females, the result is female chicks with buff colored (gold) down, and male chicks with white (silver) down. Columbian Rock females mated with Dominant White males possessing the gold genotype as found in New Hampshires, will also produce silver and gold sex-linked chicks. The plumage of broilers in this cross is more desirable than that from a regular New Hampshire-Columbian Rock cross because the dominant white eliminates the black feathers of the Columbian pattern and reduces the color in red plumage. This easy identification of sex at hatching time may be an advantage under certain types of operations where the sexes are raised separately and the females sold as broilers and the males as roasters.

Some strains of breeds such as the Columbian Rock, which have been selected for egg production as well as for meat qualities, may produce good broilers when mated with suitable dominant white broiler males. We found that crossbred male broilers from our Dominant White and Columbian Rock strains averaged 4 pounds in weight at 9 weeks of age which is approximately the same weight as the average for all entries in the Tenth Central Canadian Meat Test in 1961. They were equal in fleshing and plumage to their dominant white parents and they presented a very desirable appearance in uniformity and bloom.

Carcasses from 9-week-old broilers showing differences in conformation. L/r: Columbian Rock, Crossbred, Dominant White.

The author is head of the Animal Science Section, CDA Research Station, Fredericton, N.B.

***Above:* Highland, Hereford, and Highland-Hereford first-cross cows on the range. *Upper right:* A Highland-Hereford first-cross cow with her calf. *Lower right:* A group of Highland calves.**

RANGE CATTLE RESEARCH

Scottish Highland breed studied for improved productivity under Canadian western range conditions.

J. E. Lawson

AT THE Experimental Farm, Manyberries, Alta., we have a broad research program devoted to finding breeds or combinations of breeds with improved productivity under range conditions. Here, the Brahman cross-breeding and Cattalo projects have been under way for some years. Recently, the Scottish Highland breed has been introduced into a project to determine if its heavy hair coat contributes to increased winter hardiness. A comparison was made of the Highland and Hereford breeds and their reciprocal crosses. Feedlot, carcass and hair coat characteristics of steers and the reproductive performance of cows were included in the study. The accompanying table (see page 10) gives the breed averages (adjusted for year effects) for each of 11 traits.

The Hereford exceeded the Highland in birth weight, average daily gain in the feedlot, efficiency of feed utilization, dressing percentage and carcass grade and was surpassed by the Highland in rib-eye area and length and thickness of hair fibers. The Hereford × Highland superiority in carcass grade was the only significant difference between the reciprocal cross groups. The crossbreds were superior to the Highland in birth weight, average daily gain from birth to weaning, average daily gain in the feedlot and carcass grade, and intermediate between the parent breeds in the length and thickness of hair fibers. The Hereford and crossbreds did not differ significantly in weight per day of

Concluded on page 10

The author is an animal husbandry specialist at the Experimental Farm, Manyberries, Alta.

Sparkle. Première récolte; quatrième cueillette.

Sparkle. Deuxième récolte; quatrième cueillette.

Pourquoi une seule récolte de fraises de votre plantation?

C. E. Ste-Marie

MALGRÉ les efforts déployés depuis une décennie par tous ceux qui s'occupent de la culture de la fraise dans le Québec, les succès obtenus sont bien en deçà de nos espérances.

Nous croyons que les principales causes de ces insuccès sont: l'emploi de variétés fortement atteintes de maladies virales; les plantations gardées en rapport trop longtemps; les façons culturales mal comprises et mal exécutées; le mauvais endroit et la préparation insuffisante du terrain; enfin, l'absence de systèmes d'irrigation si nécessaires à la protection contre les gelées et les sécheresses.

M. Ste-Marie de la Ferme expérimentale de l'Assomption, Qué., est spécialisé dans les recherches sur les fruits.

Fort heureusement, depuis 1960, on put entrevoir une ère nouvelle avec la venue des variétés Cavalier, Redcoat, Sparkle et Guardsman. Tous les producteurs reconnaissent maintenant la grande vigueur et la forte capacité de production de ces variétés. Plusieurs utilisent un système d'irrigation, tant pour protéger leurs plantations contre les gelées tardives du printemps que pour sup-

TABLEAU 1: DIFFÉRENCE DE RENDEMENT ENTRE LA PREMIÈRE ET LA DEUXIÈME RÉCOLTE DE FRAISES DE LA MÊME PLANTATION

Variétés	Quatre récoltes de première année 1955–57–59–61	Quatre récoltes de deuxième année 1956–58–60–62	Différence en livres à l'acre
	Rendements moyens en livres à l'acre		
Cavalier	10,882	7,741	3,141
Redcoat	14,502	11,510	2,992
Sparkle	14,413	12,118	2,295
Guardsman	15,204	12,760	2,444

Guardsman. Première récolte; quatrième cueillette.

Guardsman. Deuxième récolte; quatrième cueillette.

Redcoat. Première récolte; quatrième cueillette.

Redcoat. Deuxième récolte; quatrième cueillette.

pléer à une précipitation insuffisante au cours de la saison. Les résultats commencent à se faire sentir puisque certains producteurs ont déjà obtenu des rendements variant de six à huit tonnes de fraises à l'acre. Ces résultats permettent de croire que les producteurs du Québec qui suivent bien les directives données par les spécialistes pourront soutenir avantageusement la concurrence. Ils auront bientôt un abondant volume de fraises d'excellente qualité pour alimenter leur propre marché et ils pourront aussi réaliser de bons profits.

La preuve étant faite que la culture de la fraise dans le Québec peut être rentable, les producteurs devront néanmoins, après s'être procuré des plants de fraisiers dits exempts de virus, s'empresser d'améliorer leurs façons culturales et de suivre à la lettre toutes les directives que leur donnent les spécialistes, les directives qui visent la mise en marché aussi bien que celles qui ont trait à la production.

TABLEAU 2: DIFFÉRENCE EN NOMBRE ET EN POIDS DES FRAISES DE 1re ET 2e RÉCOLTE DE LA MÊME PLANTATION POUR LES ANNÉES 1959-1961

	Première récolte		Deuxième récolte	
	Nombre de fraises par chopine	Poids des fraises en grammes	Nombre de fraises par chopine	Poids des fraises en grammes
Guardsman	31	10.5	36	8.8
Redcoat	34	8.1	38	7.3
Sparkle	36	7.6	42	6.6
Cavalier	44	6.3	47	6.0

Connaissant assez bien les producteurs pour savoir que beaucoup d'entre eux seraient tentés de garder leurs plantations pour une deuxième et même une troisième récolte, nous avons dès 1955 décidé de garder les variétés nouvelles pour une deuxième récolte afin d'en mieux connaître le comportement.

Les conditions atmosphériques ont beaucoup varié, au cours des huit années, 1955-62, ce qui donne d'autant plus de valeur aux chiffres du tableau 1. Tantôt la saison était hâtive et les gelées tardives du printemps causaient du dommage, tantôt elle était tardive et s'accompagnait de périodes de sécheresse et tantôt encore elle devenait un amalgame de toutes ces conditions fâcheuses. Ajoutons ici qu'en 1961 et 1962, par exemple, l'irrigation des plantations aurait permis d'obtenir des rendements beaucoup plus élevés.

Peu de producteurs réalisent que, pour couvrir les frais de production d'un acre de fraises, il faut récolter environ cinq mille livres de fruits. S'ils veulent faire

Cavalier. Première récolte; quatrième cueillette.

Cavalier. Deuxième récolte; quatrième cueillette.

face à la concurrence et réaliser un profit convenable, ils doivent alors tout mettre en œuvre pour obtenir au moins huit à dix mille livres à l'acre. Beaucoup de producteurs ont déjà dépassé cet objectif.

Voyons brièvement ce qu'auront à faire les producteurs qui veulent garder leurs plantations pour une deuxième récolte. D'abord, les travaux de rénovation doivent se faire dès la dernière cueillette terminée. Cette opération se fera donc à une période de l'année où, généralement, la précipitation est déficiente. Les applications d'engrais chimiques recommandées seront lentes à produire leurs effets; les mauvaises herbes qui ont poussé durant la période des cueillettes seront difficilement réprimées par les herbicides; les sarclages seront coûteux, sans rien dire des pulvérisations nécessaires au contrôle des insectes et maladies. Toutes ces opérations pour aboutir, dans presque tous les cas, à des rendements souvent moindres que ceux rapportés au tableau 1.

Toujours en vue de rendre service aux producteurs, nous avons, au cours des années 1959-61, recueilli des données sur le nombre et le poids des fruits des première et deuxième récoltes d'une même plantation. Ces données apparaissent au tableau 2.

Les chiffres représentent la moyenne pour les trois années.

Nous voyons donc que les fruits de la première récolte, pour les quatre variétés inscrites au tableau 2, sont plus gros et de poids plus lourd que ceux de la deuxième récolte. La cueillette se fait donc plus facilement et plus rapidement et les fruits y gagnent en apparence et commandent alors des prix plus élevés.

Nous pouvons conclure en disant que:

1) les rendements de la première récolte dépassent de beaucoup ceux de la deuxième;

2) l'écart des profits, à l'acre, est plus grand;

3) la répression des mauvaises herbes, des insectes et des maladies devient plus facile et moins coûteuse;

4) la rénovation de la fraisière comporte de gros risques que peu de producteurs peuvent encourir s'ils veulent réaliser des profits convenables; et

5) sauf pour les premières cueillettes, les fruits de la deuxième récolte sont plus petits.

Obtaining a mid-rib hair sample, one inch square, using notched clippers.

Range Cattle Research . . . from p. 7

age to the end of the feedlot period.

We have found that the Highland has not exhibited superiority in the characteristics which could result in its being recommended for use as a pure breed under range conditions. Its greatest potential area of use appears to be where extreme environmental conditions restrict the productivity or affect the survival of other breeds. In Western Canada this might be the mountainous areas or the consistently cold, often insect-infested northern regions. On the other hand, the Highland-Hereford first-cross cows have exceeded both of the parent breeds in productivity under range conditions.

The Highland, Hereford and first-cross cows produced on the experiment have been retained for further study.

	Hereford	Highland	Highland × Hereford	Hereford × Highland
Birth weight (pounds)	69.2	63.3	73.3	70.0
Average daily gain, birth to weaning (pounds)	1.46	1.41	1.57	1.61
Average daily gain, feedlot (pounds)	1.86	1.59	1.85	1.71
Weight per day of age, birth to the end of test (pounds)	1.74	1.57	1.82	1.77
Total digestible nutrients per pound gain (pounds)	5.23	5.55	5.11	5.28
Dressing percentage	57.0	55.1	56.4	57.3
Carcass grade*	1.6	3.3	2.3	1.8
Rib-eye area, adjusted for carcass weight (square inches)	8.86	9.44	9.25	9.34
Hair fiber length (millimeters)	37.5	61.5	49.5	51.1
Hair fiber thickness (microns)	32.8	36.0	35.0	34.3
Number of hair fibers (per square inch)	5274	5064	5093	4678

* Numerical values: Choice = 1 Good = 2 Standard = 3 Commercial = 4 Utility = 5

Left: Fistulated cow with moderately severe bloat at which stage treatment is started. *Center:* The viscous rumen foam being ejected through the opened fistula by pressure developed in the rumen. *Right:* The animal as she normally appears. The ejected foam is in front of the left hind foot.

PASTURE BLOAT

J. M. McArthur AND J. E. Miltimore

BLOAT occurs in ruminants when they cannot belch the gases produced by rumen fermentation. Bloat can be caused by a mechanical blockage of the throat by food or by anatomical or physiological abnormality but this is a rather rare occurrence. Bloat sometimes occurs on very lush grass and cereal grain pastures but this is also rare. Far more frequently bloat occurs when fresh young legumes and occasionally legume hay, usually the second or third cutting are fed. On these feeds, under certain conditions, the animal cannot get rid of the gas in the normal manner by belching. If the condition is not relieved, the pressure in the rumen increases and the animal soon dies. The annual loss due to death is estimated to be one to two per cent of the ruminant population. Actual losses may be much higher because of reduced production, treatment costs, time spent observing grazing animals and the restricted use of legumes. Because curative treatments will not eliminate the latter losses, the work at Summerland is directed toward finding reliable preventive methods.

In our studies with rumen fistulated cattle at the Summerland Research Station, we found that when a viscous, stable foam formed in the rumen the animals bloated. At other times there was little or no foam present in the rumen. Our findings support the theory that bloat is caused by a foam in the rumen which traps fermentation gases and prevents belching. There are three foaming agents which could be responsible: saponin, cytoplasmic protein in legumes, or mucoprotein in saliva. Each of these agents will produce a stable foam only in a specific pH range. To determine which produced the foam in bloat, we devised a method to measure the rumen pH in fistulated animals, over long periods. The results showed that the cytoplasmic protein of legumes was responsible. Further, our laboratory studies on the foam confirmed that the agent was a protein. There does not appear to be any difference in the foaming agent in alfalfa, Ladino and red clover. Considerable progress has been made on the extraction and purification of the foam agent and it appears that further purification is possible.

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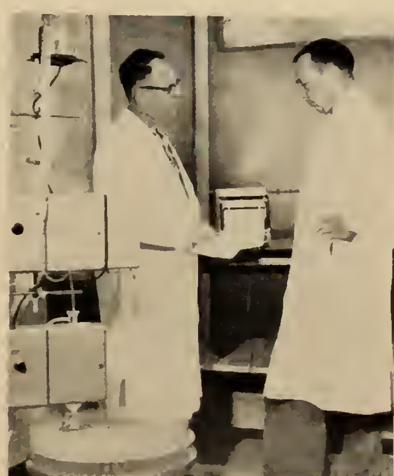
Drs. McArthur and Miltimore, chemist and biologist respectively, are specializing in bloat research at the CDA Research Station, Summerland, B.C.

Dr. McArthur (left) and Dr. Miltimore examining the fractionator chart. The legume cytoplasmic proteins are absorbed on a modified cellulose column (left center) and eluted with a buffer solution of increasing salt content from the vessels above. The protein fractions are detected as they come off the column by ultraviolet absorption. In the lower part of the apparatus, the effluent is divided into fractions of equal volume and placed in test tubes. The chart shows the number of protein fractions, the quantity and which tubes they are in.



Above: **Severe black knot infection on a plum tree in a commercial orchard.** ***Upper right:*** **New knots on plum seedling.** ***Lower right:*** **The black knot fungus growing beneath the bark forms new knots next to old ones.**

Nature Helps Control Black Knot of Stone Fruits

C. O. Gourley

For more than a century black knot caused by the fungus *Dibotryon morbosum* (Sch.) Th. & Syd. has been a scourge of plum trees in this country. It attacks all varieties and is the main deterrent to plum production in Nova Scotia. Occasionally knots are found on sour cherry, apricot, peach and ornamental *Prunus* sp. The wild bird or pin cherry and the chokecherry are very susceptible to black knot and the disease may readily spread from these wild hosts to the cultivated plum.

There are, of course, recommendations for controlling black knot on the cultivated plum—prune out existing knots and protect the new wood with fungicides during critical spring growth. But what part does nature play in controlling black knot of stone fruits? At Kentville we have been studying this question.

In our study of the life history of this fungus we found that it requires two years from the time the wood becomes infected until it can spread the disease. Spores called ascospores, ejected from mature knots between the period of bud break and shuck fall, are primarily responsible for new infections on the wood. Our research has shown that over 90% of new infections occur on new wood during this period. On artificially inoculated plums at Kentville new infections developed slowly, requiring 3 months or more to produce visible swellings on the wood. The following spring a rapid swelling of infected tissue took place and, during June and July, the bark broke open to expose a straw colored knot. This color rapidly changed to one of a velvety, olive-green due to the production of numerous summer spores called conidiospores. These summer spores are not considered important in the spread of the disease since we, along with researchers elsewhere, have found they seldom cause new infections. During the late summer and fall, the conidiospores disappear, the knots turn black as bodies called perithecia begin to develop. By spring these perithecia mature new ascospores which are ejected during warm rainy periods. These ascospores are borne by air currents to parts of the same tree or to other trees to cause new infections. In no case did we observe the life cycle of the black knot fungus to be completed in less than two years. Our studies have shown that, unless pruned off, the fungus will continue to spread under the bark of infected wood and form new knots adjacent to old ones. Because of the successive

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Black knot on peach seedling.

development of knots, ascospores are present every spring to spread the disease.

Serious outbreaks of black knot appear to occur in cycles. In Nova Scotia, we found that this disease increased in severity on both wild and cultivated hosts from 1954 to 1959. Black knot was never reported on peach until I discovered it in a commercial orchard in 1954. Successful artificial inoculations of peach using ascospores from a plum knot indicated to us that a strain of this fungus able to attack peach is now present. Since 1959 there has been no apparent increase in the incidence of black knot. This we think is due to the parasitism of the knots by other fungi.

In our investigations, we placed spore traps in a commercial orchard of severly infected, unsprayed plum trees to catch windborne ascospores. We trapped none in this orchard. Why? To determine the reason we examined 100 knots from this orchard in the laboratory. All the knots were heavily parasitized by other fungi. A few black knot perithecia contained ascospores but in most they were completely lacking.

Our study revealed that fungi such as a *Fusarium and Coniothyrium* species and *Cephalothecium roseum* were the most commonly found parasites of the black knots. It was not uncommon to find one of these organisms as the only other inhabitor of a knot and often in its presence the black knot perithecia contained no ascospores. Usually, several organisms were found on the same knot. Our investigations showed that, in the orchard where these knots were collected, the contaminating fungi almost completely suppressed the development of ascospores of the black knot fungus. On several occasions, I have observed wild hosts on which the black knot fungus had been killed by the action of these fungi.

A characteristic commonly found among species of fungi is that they may produce toxins that prevent the growth of other fungi. In our investigations, we found that the black knot fungus does not possess this characteristic and appears to have no natural defence against the encroachment of other fungi. The competition for the knot substrate by the other fungi appears to suppress the development of ascospores of the black knot fungus. This could be the effect of one or several fungi on the same knot. Our experiments have shown that *C. roseum* produces a substance toxic to *D. morbosum* and that it could prevent the development of ascospores of the black knot fungus. The species of *Fusarium* and *Coniothyrium* did not produce a toxin but we did find these two fungi growing and producing their own spores inside the perithecial cases of the black knot fungus. We concluded that these three fungi were parasitic on the black knot fungus. Several other fungi though not as common, were found on the knots examined in the laboratory. Our experiments in the laboratory showed that these also suppressed the growth of the black knot fungus. We concluded that their competitive action would suppress the development of the black knot ascospores in nature.

This form of biological control of black knot should greatly reduce the inoculum potential from neglected cultivated and wild hosts. It is also considered responsible for the ebb in the disease cycle. However, this should not be interpreted as a means for relaxing the recommendations for the control of black knot on the cultivated plum.

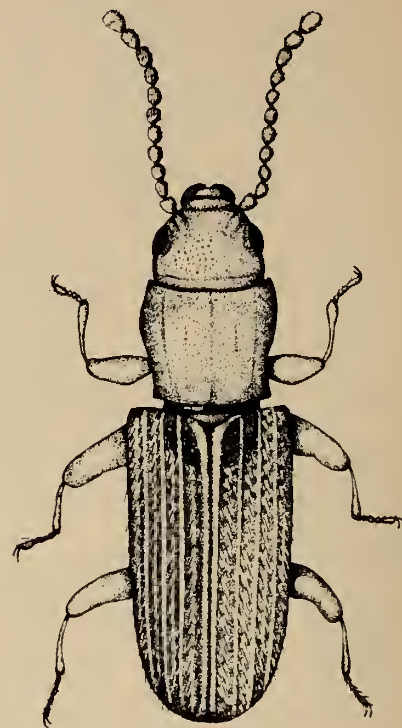
Pasture Bloat . . . from p. 11

The object is to obtain the agent in a pure form so that the effect of other factors, such as salt concentration, viscosity, and surface tension, on the development of rumen foams can be studied for qualitative and quantitative determination.

New Zealand workers have found evidence that plant fats are not present in the rumen ingesta of bloated animals but are present in non-bloated animals. Since fats and oils have long been used for the treatment of bloat, this indicates the interesting possibility of legumes with 'built-in' bloat preventives. In our studies at Summerland, we have found indications that bloat is more prevalent on low-sulfur soils. Recently, a sulfur-containing fat (sulfolipid) was found in appreciable quantity in legumes. Its molecular structure indicates that it is a good anti-foaming agent, and it would appear that sulfur nutrition of legumes and their bloating potential may be related. Another group of plant fats which have anti-foaming properties are the phospholipids (fats containing phosphorus). Although there has been relatively little work done on plant fats, it appears that the sulfo- and phospholipids amount to half or more of the total fats. It may be possible to obtain legumes with a sufficiently high lipid content that they won't cause bloat.

The plant contains both foaming and anti-foaming components and the interaction between them determines whether or not the animal will bloat. The production of non-bloating legumes requires a study of the effect of factors such as maturity, temperature, day length and soil fertility on the balance of the components in the growing plant. So far it has not been possible to screen bloating legumes for safe varieties or genotypes because the laboratory procedures are still under development. The solution may be low bloat potential legumes grown and harvested under optimum conditions.

Grain caked by heating due to activity of rusty grain beetle (right).



Adult.

The Rusty Grain Beetle

A Pest of Stored Grain

L. B. Smith

THE rusty grain beetle, *Cryptolestes ferrugineus* (Steph.), will always be an important storage pest especially when grain is stored for appreciable periods on farms and in temporary commercial premises.

In our investigations at the CDA Research Station, Winnipeg, Man., most of the infestations found on the Prairie Provinces were associated with heating grain. Whether the insects caused the heating or were simply favored by heat produced by some other organism is not well understood. It appears that the rusty grain beetle can raise the temperature of the grain through its own growth processes provided the initial grain temperature is favorable for development. However, before the role of this insect in heating grain can be accurately determined, its ecology must be understood.

The life history at certain conditions of temperature and humidity has been worked out at Winnipeg. The beetles deposit their eggs under the outer layer of the kernel or in cracks and crevices on the outside of it, and the larvae that emerge feed principally on the germ but occasionally on the starchy portion as well. Each larva molts four times before it reaches the pupal stage. The pupa is usually formed in the kernel, either under the outer layer at the germ end or in the crease of the grain, often in a weak silken cocoon.

The rate at which the larvae develop varies according to the temperature, type of food and to some extent, humidity. Our studies show that the fastest recorded development from egg to adult is 24 days. We obtained this value at 86°F. and 70 per cent relative humidity on wheat grains and on whole wheat flour. The lowest temperature at which development has been recorded is 70°F. (98 days); the highest is 100°F. (24 days). However, it seems likely that the species can develop slightly below and above this temperature range.

The lowest temperature at which these insects can develop is of interest in Canada, since the reproductive rate of a population must be as high as, or higher than, the mortality rate if that population is to maintain itself or increase. If the temperature is too low for egg laying, then the population will not cause serious damage because it does not increase. Activity and growth rate are also reduced so that less grain will be eaten. Therefore, no special treatment of the grain will be necessary so long as its temperature is expected to remain low.

The food on which development is most rapid is wheat while other cereal and oil-bearing seeds such as oats, barley, corn, sunflower seeds or flax are less favorable. Experiments have shown that the germ fraction of the wheat permits the most rapid development, followed by bran and starch. Our experiments detected no difference in growth rate when coarsely ground or whole wheat was used for food, but mortality was much higher with finely ground wheat.

In addition, the moisture content of the food must be at a certain level for maximum egg laying. Our laboratory experiments showed that grain at 16 per cent moisture content is most suitable for the egg laying of these beetles. On grain of 16-20% moisture content, egg laying was slightly reduced while at 14%

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moisture content very few eggs were found.

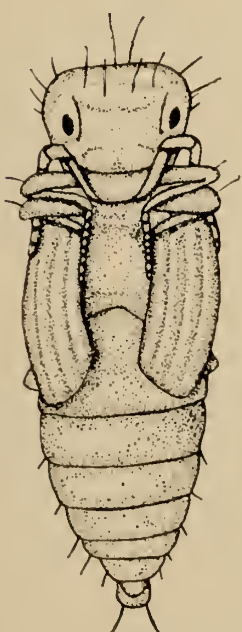
Our studies also revealed that the structure of the kernel is important since eggs are not laid on the surface of the kernels unless there is a crevice or fold in the outer covering that is suitable for holding eggs. In commercially stored wheat, we consider that 40-60% of the kernels have the outer layers damaged sufficiently to permit egg laying. The outer layer is usually broken at the germ. The break probably occurs when the kernel, which is attached to the stalk in the wheat head, is torn away during the threshing operation. Furthermore, in a dried kernel, we noticed that there is an air space between the germ and the outer layer which made the brittle outer layer more susceptible to damage from violent contact with walls or other kernels during the loading and unloading operations.

Even if the eggs are laid outside the kernel, we confirmed that newly-emerged larvae can still enter provided there is a crack in the outer layer, even if the crack is only microscopic. The larvae can then complete their development inside the kernel. Usually the pupal stage is spent in the kernel also, although occasionally the pupa may be formed outside of it.

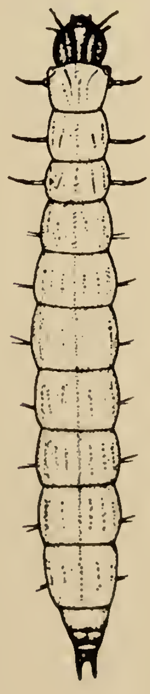
During development, each larva produces a small amount of heat which in itself would not be enough to cause significant heating, but the cumulative effect of many larvae may lead to high grain temperatures. Moreover, the stage of development will affect heat production; the larger the larva the greater the amount of heat produced. It has been found that heating occurs when large numbers of third and fourth instar larvae are present in a mass of grain. There may be a critical density of insects needed before heating will occur and, if so, knowledge of the factors that regulate the population growth of the rusty grain beetle is necessary to determine when this critical density will be reached. We know from our experiments that, at low densities, egg laying and development rates are high while mortality is low. Thus, rusty grain beetle populations increase rapidly when density is low, but as density increases, our work has shown that egg laying and development rate decrease and mortality increases. The net result of these inter-related changes is a gradual decline in population growth until it eventually ceases altogether.

As a result of our investigations, it can be said that the most important conditions favoring the development of infestations of the rusty grain beetle in stored grain are a temperature near 86°F., moisture content of 16 per cent or more, and damaged or wrinkled outer layers of the kernels. If none of these conditions exist, it is very unlikely that large populations could be produced in stored grain. Therefore, to reduce the possibility of infestation by rusty grain beetles, grain in storage should be kept cool and dry, if possible below 70°F. and 14 per cent moisture content. It is not practical to attempt to reduce damage to the outer layers of the kernels. However, since a residual population of rusty grain beetles is required to initiate an infestation, effort should be directed to reducing this as much as possible. Empty storages should be swept out to remove grain residues and dust on which a population could survive until new grain is loaded into the building. Then the walls should be sprayed with an insecticide such as lindane and malathion. Large infestations already in the grain should be treated with a fumigant containing methyl bromide, ethylene dichloride, ethylene dibromide, carbon disulfide or carbon tetrachloride. If these control measures are carefully followed, the rusty grain beetle should not cause any damage in stored grain.

Pupa.



Larva.



Egg.

Spring flood scheme on South Rush Lake near Swift Current, Sask. (See front cover also.)

Spring Flood Irrigation on the Prairies

Studies on Soil Moisture Variations and Salinity Conditions Explain Why this Irrigation Method is Beneficial

J. C. van Schaik

SPRING FLOOD IRRIGATION schemes offer prairie farmers and ranchers assurance of some winter feed for livestock. Although PFRA assistance to farmers is mainly for construction of farm-sized dugouts or dams, some work on spring flood irrigation layouts (about 7,000 acres as of 1960) has been done. In our soil salinity and drainage studies at the CDA Research Station, Lethbridge, Alta., we have been investigating some problems in spring flood irrigation.

A major handicap of spring flood irrigation is that the water is applied at a time of the year when the soil is still frozen. Infiltration of water into such a soil is hampered and most of the water is lost as run-off. However, we have found that when circumstances permit the ponding of water for some time, it is possible that the soil can be brought to field-capacity level. An example was on a portion of the Rush Lake project near Swift Current, Sask. This soil is of lacustrine origin with a texture of silty clay loam to clay and has an available moisture range of approximately 3 inches per foot.

The accompanying table shows how beneficial the spring flood irrigation was during the two years that soil moisture samplings were carried out. Results are also given for dry land where natural run-off was the only contributing factor for any increase of moisture over the winter. Each spring, we found that the soil in the spring flood area was close to field capacity after irrigation.

These can be considered as two extreme years with a high precipitation in the fall of 1959 and a very low precipitation in 1960. Therefore, when flood irrigation is applied, the increase in soil moisture may vary between 3.7 and 9.8 inches for the *surface 3 feet* of this fine-textured soil.

In this study, we also observed that by June 30 in both years the moisture content of the surface 3 feet was below the 50 per cent level of available moisture. This date may be considerably earlier if the soil is coarse-textured. After the grass was cut in July there was not sufficient moisture available to produce a second cut.

Our investigations have revealed that some irrigation projects, constructed on old lakebeds with poor natural drainage such as the Rush Lake project, are gradually becoming saline. To prevent this salt accumulation it is suggested that spring flood irrigation be applied rather than summer irrigation. In the spring the upward movement of water with its dissolved salts is slower than in summer because of lower evaporation and transpiration. Accumulation of salts at or near the soil surface, which is detrimental to crop growth, is therefore slower in the spring than during the hot summer months. To minimize surface salt accumulation and thereby maintain the productivity of the soil, spring flood irrigation is recommended. Any apparent benefits from summer irrigation in these areas are offset in the long run by the harmful effects of salinization.

CHANGES IN SOIL MOISTURE, IN INCHES PER FOOT, SINCE THE PREVIOUS FALL AFTER SPRING FLOOD IRRIGATION AND NATURAL RUN-OFF

Depth (ft.)	1960 Spring flood	1960 Natural run-off on dry land	1961 Spring flood	1961 Natural run-off on dry land
0–1	+0.0	−0.9	+4.4	+1.4
1–2	+2.2	+1.0	+3.7	+0.4
2–3	+1.5	+1.1	+1.7	−0.1
(Surface 3 feet)	(3.7)		(9.8)	
3–4	+0.6	+0.1	+2.2	+0.3
4–5	+0.6	−0.2	+1.9	−0.2

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